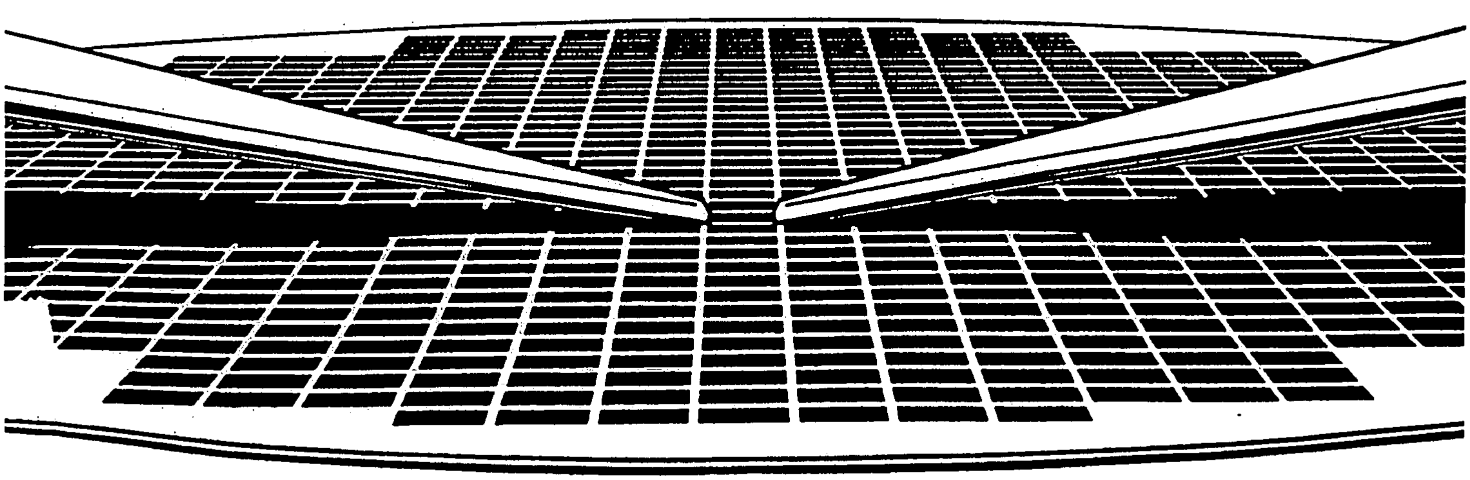
CASCADE MICROTECH®

Probe Heads

Care and cleaning of coaxial input microwave probes

MICROWAVE PROBE CARE AND CLEANING

Instruction Manual



Warranty

Statement

Cascade Microtech, Inc. (CMI) hardware products are warranted against defects in materials and workmanship. If CMI receives notice of such defects during the warranty period, CMI shall at its option, either repair or replace hardware products which prove to be defective.
Repairs made on CMI hardware products will be accomplished at no additional charge, exclusive of repairs necessitated by shipping damage. Repairs will be made at Customer's expense for damage not covered by CMI warranty.

Duration and Commencement

The warranty period for each hardware product is 1 year from date of shipment.

Place of Performance

Products must be returned to a specified CMI service facility when under warranty. The Customer shall prepay shipping charges (and shall pay all duty and taxes) for products returned to CMI for warranty service. CMI shall pay shipping charges for return of products covered by CMI warranty.

Packaging

Products not returned in proper packaging will not be covered by the CMI warranty and repairs will be made at the Customer's expense. Proper packaging includes the original CMI shipping container or a CMI supplied shipping container.

Exclusions

The foregoing warranty shall not apply to defects resulting from:

- Improper or inadequate maintenance by Customer;
- Improper packaging for reshipment;
- Unauthorized modification or misuse;
- Operation outside of the environmental specifications for the product; or
- Improper site preparation and maintenance.

The foregoing warranty is in lieu of all other warranties, express or implied, including, but not limited to the implied warranties of merchantability and fitness for a particular purpose, which are hereby disclaimed. In no event will Cascade Microtech, Inc. be liable for consequential damages, even if Cascade Microtech, Inc. has been advised of the possibility of such damages.

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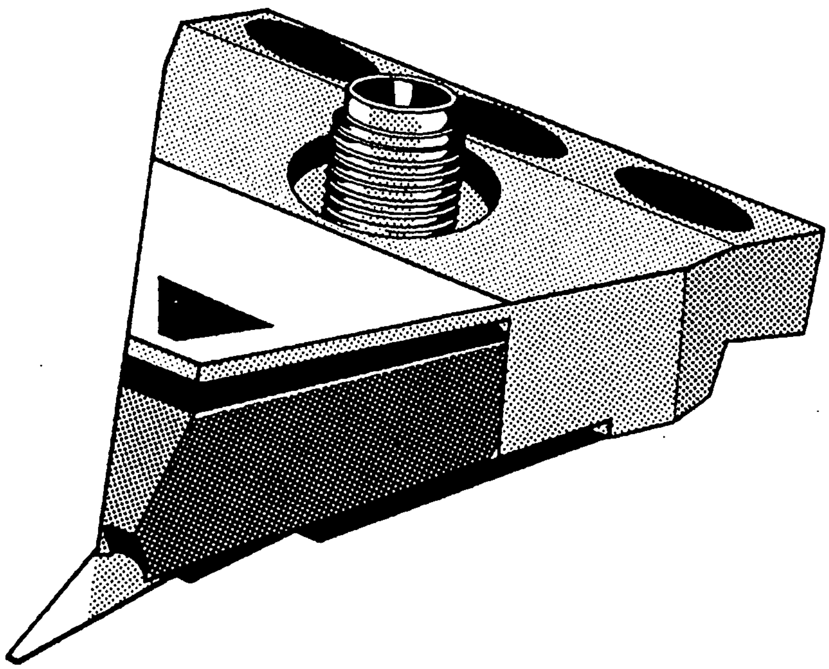


Contents

Introduction

In this manual

Microwave probe heads This manual provides instructions for the Cascade Microtech coaxial-input microwave probe heads. Cascade Microtech microwave probe heads are designed to provide accurate microwave and millimeter-wave measurements.

The microwave probe head provides a 50 ohm transmission line between the coaxial connector and the device under test (OUT) pads. The probe head design permits multiple coaxial cable connections. The probes are mounted on Cascade Microtech probe stations, probe fixtures, autoprober top plates, probe holders, and probe cards.

Introduction chapter This chapter has microwave probe and auxiliary equipment descriptions.

Operation chapter The OPERATION chapter includes probe installation and setup. A dc biasing section covers maximum probe current, and provisions for bias.

> ◇ **Caution** Do not unpack or install probe heads until handling instructions in the OPERATION chapter are read. Probe heads can be damaged if not handled or operated correctly.

Maintenance chapter Probe maintenance procedures and troubleshooting lists are furnished.

Notational conventions

> Note Read a NOTE before proceeding.

> o Caution A CAUTION is information on preventing damage to a component, or any other action resulting in economic loss.

> + Warning A WARNING is information on preventing injury to a person.

Probes

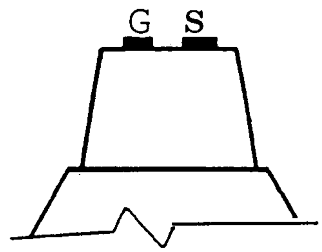


Fig. 1-1 WPH-001 -xxx probe contact sequence

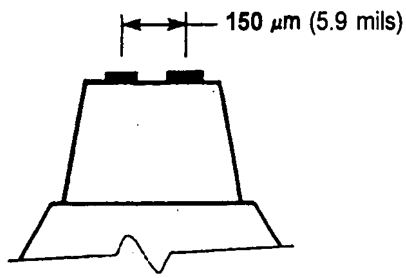


Fig. 1-2 WPH-001-150 probe contact center spacing

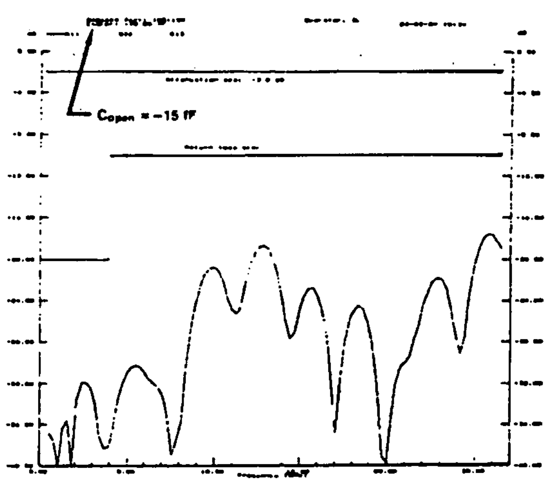


Fig. 1-3 Final-test WPH-105 probe data sheet

Types A great number of probe types are available. Ground and signal configurations are selected for the device under test. Spacing between signal and ground line contacts are chosen to suit the device pad spacing. Custom probes are available for many applications. See the Cascade Microtech *RF Probe Selection Guide.*

"Footprint" The sequence of describing the signal, ground, or other contacts is known as the "footprint." The 18 GHz WPH-001-xxx probe has a left to right ground-signal contact sequence. The GS notation (ground-signal) indicates the sequence of contacts when looking down on the probe, tip pointing away.

"Pitch" Spacing between the probe signal, ground, or other contacts is chosen to suit the device's pad spacing. The "xxx" in the 18 GHz WPH-OOl-xxx probe description is the "pitch" symbol, used to describe the spacing between contact centers.

A WPH-001 -xxx probe has a choice of 50 to 1.250 micron spacing between contact centers. The 150 suffix of a WPH-001-150 probe indicates the probe contact centers are 150 microns (5.9 mils) apart.

Data sheet Every microwave probe is accompanied by a probe-specific data sheet. Figure 1-3 shows data sheet final-test S-parameter test results for a WPH-105 (ground-signal-ground) probe.

Coaxial Input probes Additional information is available from other Cascade Microtech publications. The *RF Probe Selection Guide,* useful for purchase selection, has configuration, pitch, and specification information. The application note *Layout rules for GHz Probing* provides information on mechanical and electrical layout "rules." Data sheets are available for the WPH-200, 300, 400 series probes.

The following microwave probes have coaxial input. (Waveguide-input probes are covered in a separate publication.) The left to right sequence of contacts (when looking down on the probe, with the tip pointing away), are given for each probe,

- **RTP-105** The RTP-105 notation indicates a 26.5 GHz GSG three-contact probe, signal in the center. The RTP probe has a field-replaceable tip.

- **WPH-001** The WPH-001 notation indicates an 18Hz GS probe, ground on the left and signal on the right.

- WPH-002 The WPH-002 notation indicates an 18 GHz SG probe, signal on the left and ground on the right.

- WPH-003 The WPH-003 notation indicates an 18 GHz S_1GS_2 three-contact probe; signal 1 on the left, ground in the center, signal 2 on the right.

- WPH-004 The WPH-004 notation indicates an 18 GHz GS_1GS_1G five-contact probe; one signal fine split into two contacts, enclosed by three grounds.

- WPH-005 The WPH-005 notation indicates an 18 GHz GSG three-contact probe, signal in the center.

Probe contact width *Probe contact width is approximately 50 µm for pitch 100 pm or greater. Probe contact width for pitch less than 100 µm is approximately one half of the pitch measurement.*

- WPH-006 The WPH-006 notation indicates an 18 GHz S+S- two-contact probe. A balanced signal is assumed, thus creating a virtual ground between the two signal conductors. This probe is used with a balun, PN 010-019.

- WPH-011 The WPH-011 notation indicates an 18 GHz GS_1GS_2G five-contact probe; two signal lines enclosed by three grounds.

- WPH-016 The WPH-016 notation indicates an 18 GHz GS_1S_1G four-contact probe; the two signal lines carry the same signal. This probe is useful for pi-gate probing.

- WPH-017 The WPH-017 notation indicates an 18 GHz GS_1XS_1G four-contact probe. A space ("X" indicates no contact) is placed between the two signal lines carrying the same signal.

- WPH-018 The WPH-018 notation indicates an 18 GHz XSXSX two-contact probe. A space ("X" indicates no contact) is placed between the two signal lines carrying the same signal. This head, used only in probe cards, requires a ground strap.

Micron vs micrometer ***(10^{-6}m)***

According to the set of submultiple prefixes now established in the International System of Units, the preferred term is micrometer. To avoid confusion, within this instruction manual context, the word micron is used.

The micron symbol is µm.
1 micron = 1 micrometer
1 micro = 0 001 mm
1 mil = 25.4 microns
1 mil = .001 inch
1 mil = .0254 mm

- WPH-020 The WPH-020 notation indicates an 18 GHz GS_1S_2 three-contact probe; ground on the left, signal 1 in the center, signal 2 on the right.

- WPH-021 The WPH-021 notation indicates an 18 GHz S_1S_2G three-contact probe: signal 1 on the left, signal 2 in the center, ground on the right.

- WPH-03x-yyyy The WPH-03x-yyyy notation indicates an 18 GHz probe with two GSG contact pairs ($GS_1G...GS_2G$), The pitch of the GSG pairs can be selected as well as the distance between the two signal lines. See the *Probe Head Selection Guide* for the pitch and signal line distance choices.

- WPH-101 The WPH-101 notation indicates a 26.5 GHz GS probe, ground on the left and signal on the right.

- WPH-102 The WPH-102 notation indicates a 26.5 GHz SG probe, signal on the left and ground on the right.

- WPH-104 The WPH-104 notation indicates a 26.5 GHz **GS_1GS_1G** five-contact probe; one signal line split into two contacts, enclosed by three grounds.

- WPH-105 The WPH-105 notation indicates a 26.5 GHz GSG three-contact probe, signal in the center.

- WPH-111 The WPH-111 notation indicates a 26.5 GHz **GS_1GS_2G** five-contact probe; two signal lines enclosed by three grounds.

- WPH-116 The WPH-116 notation indicates a 26.5 GHz **GS_1S_1G** four-contact probe; the two signal lines carry the same slgnal. This probe is useful for pl-gate probing.

- WPH-117 The WPH-117 notation indicates a 26.5 GHz **GS_1XS_1G** four-contact probe. A space ("X" indicates no contact) is placed between the two signal lines carrying the same signal.

- WPH-13x-yyyy The WPH-1 3x-yyyy notation indicates a 26.5 GHz probe with two GSG contact pairs **($GS_1G...GS_2G$)**. The pitch can be selected as well as the distance between the two signal lines. See the *Probe Heed Selection Guide* for the pitch and signal line distance choices.

- WPH-205 The WPH-205 notation indicates a 50 GHz GSG three-contact probe, signal in the center.

- WPH-305 The WPH-305 notation indicates a 40 GHz GSG three-contact probe, signal in the center.

- WPH-405 The WPH-405 notation indicates a 6GHz GSG three-contact probe, signal in the center.

- WPH-700 The WPH-700 series notation indicates a multicontact probe. Signal, ground, and power contacts are typically used. Up to eight contacts can be selected.

- WPH-760 The WPH-760 series notation indicates a multicontact probe. Signal, ground, and power contacts are used on the WPH-760 series probes. Three configurations are available; WPH-762-150 (PSGSSGSSGSP), WPH-763-150 (SSPGSSGPSS), and WPH-764-150 (PSSGGSSP).

Auxiliary equipment

Ground Isolators A ground isolator acts as a bias tee for the coaxial cable shield (instead of the center conductor). A ground isolator breaks the shield ground connection between probe heads and instrumentation. Cable ground isolators allow the probe head "ground" contact (electrically connected to the coaxial shield and to the positioner biasing post) to deliver dc or low-frequency bias to the device under test (positioners are electrically insulated).

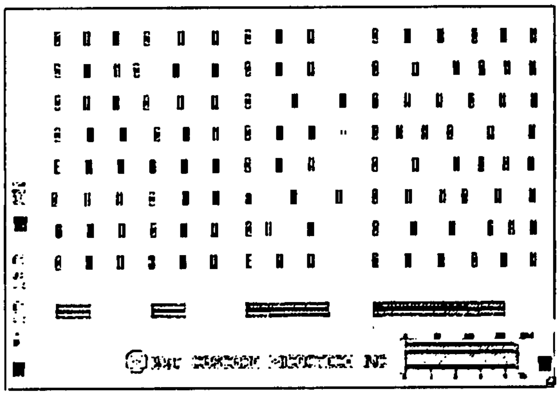


Fig. 1-4 LRM impedance atandard substrate, 1990 verslon

Impedance standard substrates Two impedance standard substrates (ISS) are available.

The Cascade Microtech LRM ISS has a compact symmetric layout optimized for line-reflect-match (LRM) calibrations with the ground-signal-ground probe. The LRM technique can do ultrabroadband calibrations with only two probe contacts to the ISS calibration elements.

The general-purpose ISS has calibration and verification standards for all standard probe heads, in most configurations. The standards are useful for making corrected and uncorrected microwave measurements.

Contact substrate A contact substrate is used for checking probe tip contact, and for probe maintenance.

Inspect upon arrival

Check for shipping damage upon arrival. Report damage or shortage immediately to the carrier and a Cascade Microtech representative.

Warranty

Read warranty Please take the time to read the warranty statement. The warranty statement is on the cover reverse.

Safetv notice

The information contained in this manual will enable you to operate the equipment effectively and safely. Careful study of this information and close adherence to the instructions, recommendations, and suggestions will contribute to satisfactory and safe service.

Any deviation from recommended practices; any modification or use for which the equipment is not designed or which departs from good industry practice, may create a hazardous or unsatisfactory operating situation. Cascade Microtech, Inc. disclaims any responsibility for consequences resulting from any such deviation, modification, or application.

Operation

Probe installation, storage

Dropping a probe head can mean an economic loss. Use care in handling and transporting the probe head.

◊ **Caution** Do not touch, bump, or snag the probe tip.

Grasp the probe head block (gold color) by using the thumb and forefinger. Pull straight up from the storage cabinet post. Move the probe to the arm and lower over the arm's locator pin. Use a 9/64 inch hex driver to snug tighten the two head-to-arm mounting screws.

Develop the habit of inspecting for din and burrs on the probe mounting surfaces at each change. Always return a probe to the storage cabinet, slipping it on a post.

Use tightened white plastic nuts to retain probes during storage cabinet movement.

Microscope viewing

Always observe the probe tips when positioning onto the device under test (DUT). The probe tips will appear out of focus when the microscope is focused on the DUT and the probe tips are safely raised.

Use the x- and y-axis micrometers to position the probe tip above the DUT. Use the z-axis micrometer to bring the probe tip down to the device.

Caution Always view through the microscope to make contact with the DUT.

Watch probe tips through the microscope when contacting a device. Do not use electrical readout as a substitute for microscope viewing when making probe contact. Observe contact and skating, then look for electrical readout.

Improper cable connections or faulty equipment may not give any indication of contact. Using electrical readout as the only contact verification can lead to probe breakage.

Probing techniques

Probe contact, with vacuum Vacuum hold down is preferred for typical probing. With vacuum, the probe tip horizontal movement is clearly seen through the microscope.

≥5 lbf/in² vacuum supply The vacuum supply to the probe station should be at least 5 lbf/in² (psi) to provide assured wafer holding to the wafer chuck (5 lbf/in² ≈ 34 kPa ≈ 20 in Hg ≈ 510 mm Hg).

Ovenravel is the continued downward vertical movement of the probe after the device has been contacted by the probe tip. Overtravel (vertical movement) is difficult to measure through the microscope but the resultant probe tip horizontal movement ("skating") is readily seen (with vacuum hold down).

Overtrevel *Overtravel is the continued downward vertical movement of the probe after the device has been contacted by the probe tip.*

Assured contact with the device pads can be typically achieved with 4 mils (0.1 mm) overtravel. Overtravel of 10 mils (0.25 mm) or less is recommended as a working maximum. A probe tip can be broken with greater than 20 mils (0.51 mm) overtra vel.

Some multicontact probes can require up to 8 mils (0.2 mm) overtravel to provide assured contact.

Contacts on probe	overtravel in mils	≈force/ contact, grams
2-4		1.6
4-8	4	1.0
E12	4-6	1.0
12-16	5-8	1.0

Assured contact with the pads of a device under test can typically be achieved with 4 mils (0.1 mm) ovenravel. Ovenravel of 4 mils develops approximately 1 gram force at each contact on a five-contact probe. Some multicontact probes require up to 8 mils (0.2 mm) overtravel to provide assured contact.

Probes have a 5-to-1 slope to the device under test. Vertical movement (after device contact) of 4 mils (0.1 mm) causes 0.8 mil (0.02 mm) horizontal movement ("skating"). The resultant 0.8 mil skating is seen at the probe tips as they move across the device (with vacuum hold down).

Over-travel of 10 mils or less is recommended as a working maximum (ovenravel greater than 20 mils can break probe tips). Vertical movement (after the device has first been contacted) of 10 mils (0.25 mm) causes 2 mils (0.05 mm) skating.

Probe tips can break if vertically deflected more than 20 mils. Vertical movement (after the device has first been contacted) of 20 mils (0.51 mm) causes 4 mils (0.1 mm) skating.

RTP-series replaceable-tip probe Overtravel of 8 mils (0.20 mm) or less is recommended as a working maximum.

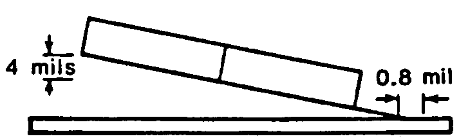


Fig. 2-1 4 mils **overtravel = 0.8 mil horizontal movement**

Probe contact, without vacuum There are benefits to not using vacuum hold down. Wear caused by repeated probing to device pads can be reduced when the device is not held by vacuum.

Take care when vacuum hold down is not used. The probe tip moves the DUT rather than skating on the surface. The combined horizontal movement is more difficult to measure than when only probe tip movement is seen. Probing without vacuum should only be attempted by experienced operators.

Two-probe contact techniques A contact technique can be used when there is more than one probe. Set the first probe down on the device, taking care to not exceed a combined (probe tip and device) maximum 2 mils (0.05 mm) horizontal movement (equates to 10 mils overtravel). After the first probe is in place succeeding probe tips can be touched to the device, then brought down to equal overtravel by operating the z-axis micrometer thimbles.

Probe tips can be damaged if two probes are "crashed" into **each** other. Keep the probe tips apart. Watch probe tip skating through the microscope as probes are brought into contact with the device under test.

◇ **Caution** Keep probe tips apart to prevent damage.

Another danger to probes A danger to probes occurs when a thin device and a thick device are left on the wafer chuck during probing. This situation can occur during the probing of a 4 mil thick wafer when a 25 mil thick impedance standard substrate (ISS) is also on the chuck. If the ISS is too close to the wafer, a probe reaching over the ISS will hit the probe behind the tip as the probe is lowered.

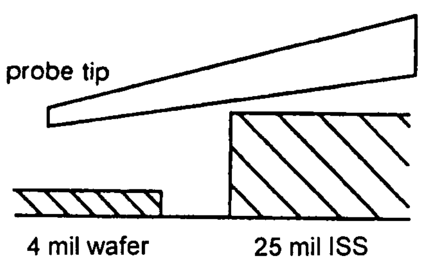


Fig. 2-2 **Avoid reaching over a thick device**

Looking through the microscope, it will not be readily apparent that the probe is supported by the ISS. It is natural to lower the probe further, since the tip is not contacting the wafer. This can damage the probe with little overtravel because of concentrated force, or the probe is simply overtravelled more than 20 mils. Use care to not reach across a thick structure when probing a thin structure.

Chip to probe sticking A chip can stick to the probe and be lifted from the wafer stage. This is due to malleable gold conforming to the probe tip.

Lift the sticking chip slightly into the air with a probe before attempting removal. Gently tap a probe to dislodge the chip, or lower one probe to push the chip off.

RTP-series probes

Flexible tip probe The Cascade Microtech RTP-series probes incorporate a flexible probe tip design. The compliant tip enables probe contact to devices that may not be perfectly coplanar with the probe tip. Another benefit of flexible probe tip design is lowered contact force, minimizing bond pad marking. However, lower contact force can prevent contact on rough surfaces, such as gouged bond pads. Also, the lower contact force can make probing aluminum metalization nonrepeatable, due to the native oxide.

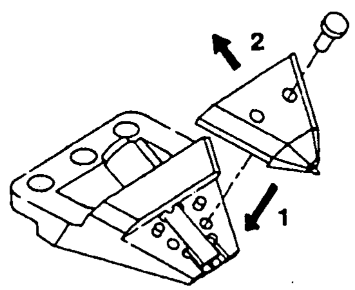
RTP probe specifications The following specifications establish the RTP probe guaranteed performance.

Inaertion loss: 2.5 dB
return loss" 10 dB
- *rured* pad contact (overtravel after Initial contact to fresh gold metallization): 2 mils (51 μm) to 8 mils (203 μm), 4 mils (101 μm) recommended

Do not expect to establish contact by "chiseling" damaged bond pads with additional overtravel, as this will simply deflect the flexible tip. Overtravel of 2 to 4 mils is all that is required on normal surfaces. Excessive overtravel (greater than 10 mils) will cause a bent tip that can be straightened by gently counter-bending with a soft-tip swab.

Although the probe tip is flexible, permanent tip damage can still occur from extreme overtravel (greater than 20 mils) or from tip-to-tip collisions. It is recommended to limit autoprober chuck travel to 20 mils maximum.

RTP probe C_{open} value A nominal C_{open} value of – 15 fF is recommended for calibration when the open circuit is established by the probe in air. Probe-specific values of C_{open} are not supplied, due to tip replaceability. C_{open} can be determined for a specific tip by using an open stub as a linear phase/monotonic magnitude reference. For greatest accuracy use LRM calibrations. An LRM calibration does not require C_{open} values. See the instruction manual for the *Microwave Wafer Probe Calibration Constants Kit.*



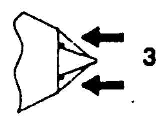


Fig. 2-3 RTP tip installation

RTP probe tip replacement A damaged or worn out probe tip is easily replaced by removing two 2-56 button-head screws with a 3/64 inch (or .050 inch) hex key. Do not handle exposed thin-film gold conductors on the replacement tip or in the probe body.

The new tip is aligned with the two dowel pins (arrow 1 of fig. 2-3), then pushed (arrow 2) down and back toward the connector (arrow 3) until it stops on the front edge of the body. Take care to not snag or scratch the tip substrate. Replace the button-head screws and finger tighten with the hex key until the tip is pulled down flush against the body. Do not ovettorque the screws! Recalibrate before continuing measurements.

700-series probe mount

Cascade Microtech multiple-contact 700-series probes require a separate panel to hold the coaxial connectors. A flexible microstrip interconnect provides connection between the probe and panel-mounted coaxial connectors. The panel is mounted to a positioner arm with an adjustable clamp.

> 0 Caution Handle the flexible microstrip interconnect, probe, and panel carefully.

The flexible microstrip interconnect can be damaged by excessive bending. Handle the probe by the connector panel.

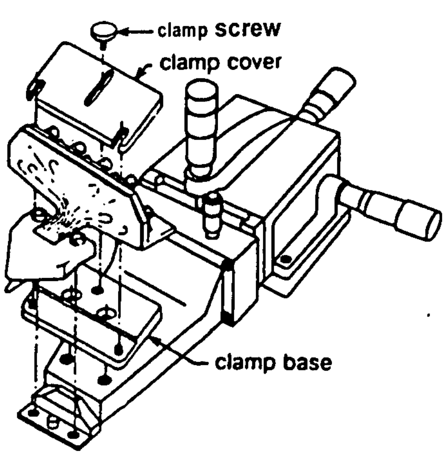


Fig. 2-4 700-series probe mount for Summit™ 9000 probe station

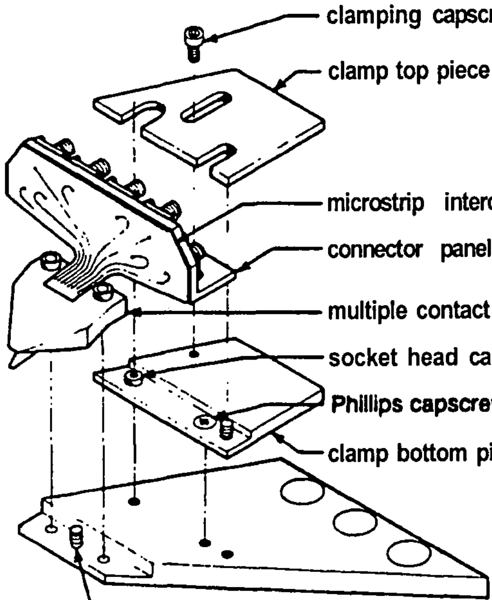


Fig. 2-5 700-series probe mount for models 12, 22, 42, 44, 52, 54, 62, 64, 72, and 74

Summit™ 9000 Analytical Probe Station Install the adjustable clamp base to the arm with two flat-head Phillips capscrews.

Move the multiple-contact probe and panel to the adjustable clamp. Lower the probe onto the arm's locator pin, then guide the panel onto the clamp bottom piece.

Use a 9/64 inch hex driver to snug tighten the two head-to-arm mounting screws. Push the clamp top piece over the panel, then snug tighten the clamp screw.

Models 12, 22, 42, 44, 52, 54, 62, 64, 72, 74 Install the adjustable clamp bottom piece on the arm. The bottom piece already has one flat head Phillips capscrew installed. Lay the bottom piece on the arm and align with two 6/32 threaded mounting holes. Install the flat head Phillips capscrew and use a 7/64 inch hex key to install the socket head capscrew.

Move the multiple-contact probe and panel to the adjustable clamp. Lower the probe onto the arm's locator pin, then guide the panel onto the clamp bottom piece.

Use the 9/64 inch hex driver to snug-tighten the two head-to-arm mounting screws. Push the clamp top piece over the panel, then use the hex driver to snug-tighten the clamping capscrew.

Probe cards

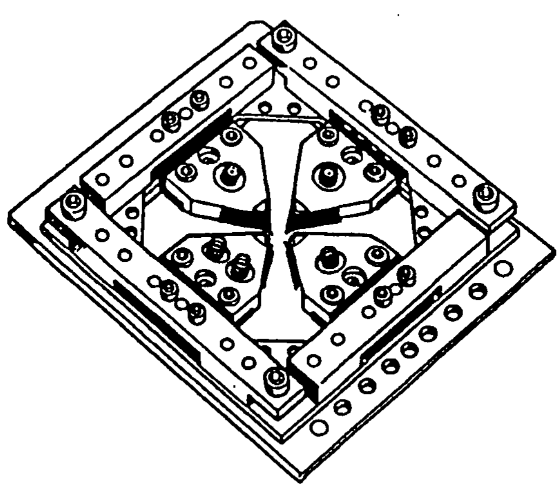


Fig. 2-6 1000-series probe card

Probe card adapter set A Cascade Microtech probe card adapter set can be used to mount 1000- and 2000-series probe cards to Cascade Microtech models 12, 22, 42, 44, 52, 54, 62, 64, 72, and 74 probe stations, probe fixtures, and autoprober top plates. See the appropriate probe station, probe fixture, or autoprober top plate instruction manual for mounting and using the probe card holder.

Summit" 9000 Analytical Probe Station probe card holder There is a separate manual for the Summit 9000 probe station probe card holder.

Alignment requirements All microwave probe heads installed in a probe card must make coplanar contact with the device under test. Probe card alignment is to be checked at every probe card installation, and change in tested device thickness.

> 0 **Caution** Switching between wafers of different thickness requires readjustment of probe card height. Check the thickness of each wafer to avoid probe damage.

Coaxial cables

Coaxial cable selection Coaxial cables should be low VSWR, with high phase stability and amplitude stability. Semirigid cables are generally the most stable. Semirigid cables are mechanically suitable, since probe heads are not significantly moved during operation.

Most flexible cables are suitable, if the cables are not moved or bumped during operation. Restrain the cables at the platen or positioner. Cable weight and torsion can affect measurements.

Type SMA, K Connector, and APC-3.5 cables and adapters can be interconnected. Overall performance is restricted to the lowest performance cable or adapter.

Swept 90-degree adapters or bent semirigid cable (do not exceed manufacturer's specified minimum bend radius) can be used at the probe head connection.

Performance is improved (especially in the network analyzer RAMP sweep mode) by using matched reference plane extender cables. Matched reference extender cables are available from Cascade Microtech.

Cable installation The probe station and an automatic network analyzer or other equipment should be placed together on a rigid table. Use a loop or an s-curve in the Interconnecting cables to provide connection without force.

Misalignment can be caused by torque applied to the probe head. Arrange cabling and other components for no rotational force applied about the probe's long axis.

Cable can be damaged by exceeding the manufacturer's specified minimum bend radius. Use large coil diameters during installation and storage. Avoid pinching or crushing cable assemblies.

Connections Align center lines before mating connectors. Gently turn the coupling nut, checking for resistance caused by pins not mated, cross-threading, or other damage.

> ◇ **Caution** Misalignment between coaxial cable and probe head connectors can cause cross-threading.
>
> ◇ **Caution** Never screw a female connector into a male connector. This rotation wears the plating and can score the outer interface rim and the pin.

Adapters can be used on connectors used for many connect-disconnect cycles. The adapter takes the wear and accidental damage, and is readily replaced.

Repair or discard a defective connector. A damaged connector can damage other connectors.

Prevent damage due to worn or out-of-specffication connectors. All connectors will wear with continued use and should be checked at frequent intervals. Inspect each connector and use a mechanical gauge to check the center pin protrusion distance.

A torque wrench (HP 871 O-l 785, Maury Microwave Corp. model 8799A, or equivalent) assures correct coaxial connection tightness. Torque value for the 5/16 inch connection is 8 lbf -in (0.9 N·m). Tightening to the correct torque value prevents damage.

Be careful when tightening coaxial connectors at the probe heads. Probe positioners prevent movement in the z-axis and restrain movement by spring force in the x- and y-axis. Excessive force can cause probe tips to collide. Watch the probes and restrain movement when making connection to each probe.

Do not attempt to remove or install a coaxial connection at the probe head when the probe is in contact with a wafer. The distant ends of coaxial cables can be carefully moved if the cables are restrained before reaching the probe.

Loose probe head connector   A probe head RF connector that turns in the probe head block is damaged and should be returned to Cascade Microtech for repair.

A probe head K Connector that turns in the probe head block can be retightened. See the following MAINTENANCE chapter, PROBE HEAD COAXIAL CONNECTORS section.

DC biasing

Maximum probe current   Do not apply more than 500 milliamperes to probes that are making and breaking contact to gold pads. A lower current limit must be observed when probing metals other than gold, such as aluminum or AuGeNi. Resultant arcing will cause probe contact damage.

Do not apply more than 1 ampere to probes that are in continuous contact, i.e., no make-and-break contact. Excessive current flowing through a probe will typically result in an opened line, rather than contact damage.

Most probe burnout is caused **by** (1) high-capacitance in the bias system or (2) a bias supply with a too-high current limit applied to a short circuit, such as a shorted FET. (Some power supplies with a correct-level current limit can still have a large surge current when the probe is shorted.)

The probe's transmission line is very small at the tip, smaller than a typical fuse, and it rapidly responds to surge currents. Discharge of a 100 microfarad capacitor charged to 10 volts can cause the tip to fail open.

Some computer-controlled power supplies are known to momentarily go to full output current and voltage upon a command to change output levels. This possibility should be investigated if evidence of high current flow is seen.

Biasing through bias tees A typical measurement applies dc bias through a bias tee to a DUT input or output. A bias tee can be a separate component, or built into an S-parameter test set. Be sure to check the maximum current rating of bias tees (most are 500 milliampere maximum).

The HP 8510 network analyzer test set bias tees each have approximately 3 ohms resistance between bias input and front panel center conductor. Total resistance between bias input and probe tip is approximately 4 ohms, due to the additional cable and probe resistance. Consider the total resistance of a bias supply system whenever applying bias to a DUT, or measuring ISS resistors.

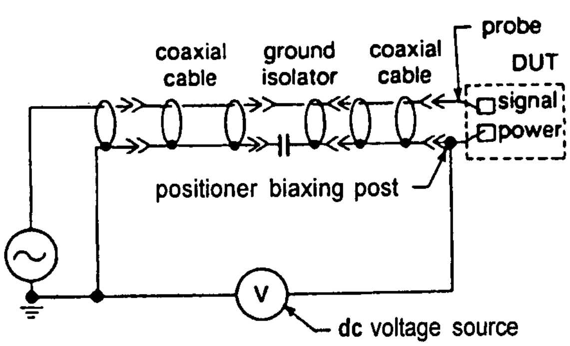


Fig. 2-7 Ground isolator In **test** circuit

Ground Isolators A ground isolator acts as a bias tee for the coaxial cable shield (instead of the center conductor). There is approximately 0.1 microfarad capacitance between the shields of the two connectors on each isolator, permitting high-frequency transmission while isolating dc.

A ground isolator breaks the shield ground connection between probe heads and instrumentation. Cable ground isolators allow the probe head "ground" contact (electrically connected to the coaxial shield and to the bias) to deliver dc or low-frequency bias to the device under test.

Connection to the probe head "floating" ground is typically made via a positioner biasing post. The ground isolators are useful for supplying a high-frequency signal to a device pad, while floating the common-lead pad to a dc voltage.

A typical ground isolator application is for minimizing inductance in the current supply path to the high-frequency output pad. For example, if the current supply for an output driver with a fast transition time is contacted through an inductive connection to the power supply, then a noise voltage Of $L_{probe} \cdot di/dt$ develops at the power supply pad (L_{probe} is the inductance from a clean power supply to the power supply pad and i is the current being drawn). A 100 mV noise level would appear on the power supply node if L_{probe} is 1 nH, risetime is 200 ps, and 20 mA flows into the output node. A 5 mV noise level would appear if a ground isolator is used to supply current with L_{probe} at 0.05 nH.

Other ground isolator uses include dc verification of a complete probe ground contact (single ground on probe), and for FET source-connection Kelvin sensing. Multiple-ground probe heads must use high-frequency instruments to reveal the high inductance produced by a missing ground path (see MAINTENANCE chapter, PROBE TIP CONTACT CHECK section).

Chuck electrical connection Electrical connection can be made to the chuck on Cascade Microtech probe stations and fixtures.

Ground Cascade Microtech probe stations, fixtures, and autoprober top plates have threaded holes in the platen outside edges or bottom plate. Connection to the bottom plate does not guarantee connection to, or insulation from the chuck.

Probing uneven devices

Excessive overtravel Do not use excessive over-travel in an attempt to overcome probe-to-device misalignment. Microwave probe tips can be broken with greater than 20 mils (0.51 mm) ovenravel (4 mils skating).

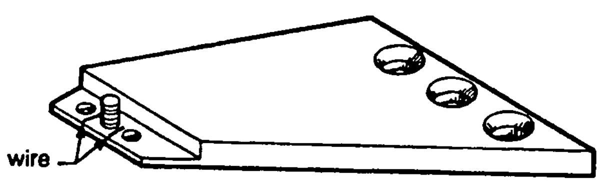


Fig. 2-8 Wire pivot placement

Planarity control The Cascade Microtech probe holders and the Summit 9000'" Analytical Probe Station have planarity adjustments. to make planar the probe-to-device contact. Adjust the planarity adjustment as required, if one side of the probe is not making contact. Probe stations, fixtures, and autoprober top plates without adjustable planarity controls can use the following probe pivot or arm-mount shim methods.

Probe pivot A device that does not have a parallel plane to the chuck top can be contacted by introducing a pivot at the probe mount. The disadvantage of this technique is that it requires probe readjustment at every probe or device change.

Remove the probe and lay approximately 10 mil gauge wire at one or both sides of the arm's locator pin. The wire is placed collinear with the probe's long axis.

Replace the probe and tighten the mounting screws until snug. The screws can now be used to pivot the probe head on the wire, making adjustments until the device can be contacted.

Arm mount shims Alternatively, an arm-mounted probe can be adjusted to the uneven device by placing shims at the arm to riser mounting surface.

Before making this adjustment, move the probe tips away from each other, and then move the chuck away from the probes.

Loosen the three arm screws slightly and introduce shims at either end of the arm to riser mounting surface. Use 5 mil shims and stack as necessary until the device can be contacted.

Maintenance

Probe tip cleaning

Dirt Sources Dirt buildup can cause the probe tip to lose contact. Clean dirty wafers before probing.

> Note Keep the probe tips clean. Clean probe tips occasionally, or when contact problems are suspected.

Look for other sources of din-caused problems before cleaning the probe tip. Check the probe mounting surfaces for din or burrs. Clean the chuck top. Clean the wafer.

Air Try cleaning the probe tip with air before using solvent. Blow from the body to the tip, almost parallel to the probe.

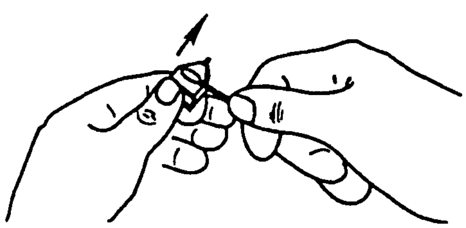


Fig. 3-1 Probe tip cleaning

Alcohol Isopropyl alcohol (IPA) is an approved solvent for cleaning probe tips. Use a small amount on a foam-tipped swab. Move the swab from the body to the tip, taking care the tip is not snagged and pulled up.

> ◇ **Caution** Do not clean a probe with trichloroethane (TCE) or acetone. Damage to adhesives and components will result!

> 0 Caution Probe types WPH-004 and -104 built before serial number 1600 do not have a protective surface coating over the 0.0007 inch wires bonded to the tip. Do not touch the tip of these probes with finger or swab.

Ultrasonic cleaner An ultrasonic cleaner can be used to clean probe tips. This is an alternative method for cleaning probes and Is the only method for cleaning probe types WPH-004 and -104 built before serial number 1600. Use clean IPA and immerse only the tip. Allow sufficient time for complete drying before placing the probe into use.

Aluminum Aluminum can stick to probe tips, causing short circuits or erratic measurements. A possble solution (depends on aluminum characteristics) is to use Vichem Corporation's GEL-PAK film (PO Box 9396; Stanford CA 94309). Periodically land the probes on the film (after about 100 landings-use number 5 retentivity film).

Probe tip contact check

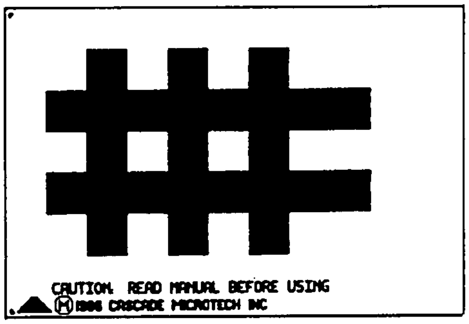


Fig. 3-2 Contact substrate

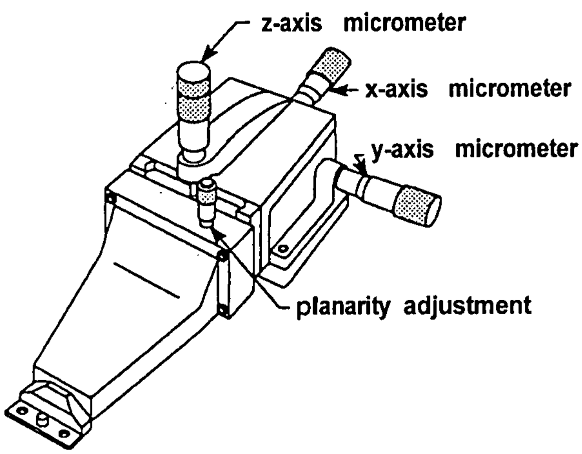


Fig. 3-3 Summit" 9000 probe station positioner adjustments

Contact check Probe tip contact can be checked before placing a probe into service or when the probe tip does not seem to be making coplanar contact with the device under test.

> Note Nearly all mechanical problems appear as noncoplanarity at the probe tips. However, most problems arise from a control setting, dirt, or other simple problem.

Bring the probe tip into contact with a large metalized area on the contact substrate, a wafer, or Cascade Microtech impedance standard substrate. Use vacuum hold down. Use 4 mils (0.1 mm) overtravel (vertical movement) to produce 0.8 mil (0.02 mm) horizontal movement.

Planarity control The Cascade Microtech probe holders and the Summit" 9000 Analytical Probe Station have planarity adjustments to make planar the probe-to-device contact. Adjust the planarity adjustment as required, if one side of the probe is not making contact.

Single-ground continuity Check for single-ground probe continuity between signal and ground leads by using a curve tracer, oscilloscope, power supply, network analyzer, etc. Check for immunity to vibration by gently tapping the platen with a finger.

A ground isolator is useful for verifying that a probe ground contact (single ground on probe) is complete. A ground isolator acts as a bias tee for the coaxial cable shield (instead of the center conductor).

Multiple-ground continuity Multiple-ground probes (WPH-004, -104, -005, -105, etc) must use a network analyzer for ground contact continuity testing. A dc indication of contact will not show whether all ground contacts are connected.

The network analyzer will indicate the lowest inductance (the least clockwise rotation with increasing frequency-on the Smith chart presentation) when all ground contacts of a multiple-ground probe are connected. One way to check this is to position the probe so that one ground is certainly not connected. Note the inductance shown on the display, then move the probe back to a position that would allow all ground contacts to make connection. Look for an inductance decrease (a lesser clockwise rotation.) It may be necessary to adjust the reference plane extension on the network analyzer to make this indication clear.

Contact tracks If contact is uncertain, lift the probes and examine the probe tip contact tracks. Contact tracks can be enhanced by adjusting the appropriate x- or y-axls micrometer to drag the probe a slight distance (with the probe tip following). Avoid lateral motion.

◊ **Caution** Do not attempt to drag the probes mounted on a probe card.

A track should be left by each probe contact. The tracks do not have to be identical. Any mark (might be faint) indicates contact.

Troubleshootlng with 180° rotation chuck Lift the probe(s) and rotate the chuck by 180 degrees (if the chuck is rotatable). (Do not move the wafer or contact substrate in relation to the chuck top.) Recheck track marks if a probe contact is not leaving a track. Suspect the probe, arm, and mounting surfaces if the missing track remains on the same side of the metalized area. Suspect the wafer, chuck, or trapped particles if the missing track changes sides on the metalized area.

Probe tip lapping

Last-resort correction Probe tip lapping is not recommended unless all other causes of contact loss are eliminated. Lapping of probe tip contacts can only be done a limited amount before the contact coating is removed or provides poor connection.

Note Adjusting the Cascade Microtech probe holder and the Summit™ 9000 Analytical Probe Station planarity adjustments will correct contact problems in almost every case.

◊ **Caution** Lapping the probe tip contacts is a last-resort correction for contacts that are not making coplanar contact with the wafer plane.

Check the probe contact track and electrical continuity on a metalized surface (see preceding section).

Lapping The probe contacts are lapped on the contact substrate. Do not use any other method for lapping.

0 Caution Lapping the probe tip contacts can only be done a limited amount before the contact coating is removed or provides poor connection.

1. LAPPING IN PLACE Install the probe head on a positioner.

2. CONTACT SUBSTRATE Place a contact substrate on the chuck, making sure there is no dirt underneath. Use vacuum to hold it to the chuck.

3. OBLIQUE ILLUMINATION Use a recommended oblique illuminator for enhanced viewing of the tracks left on the contact substrate during lapping.

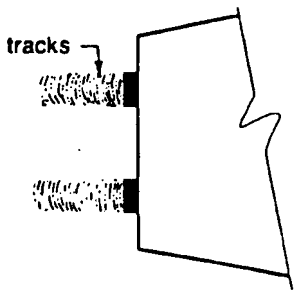


Fig. 3-4 Contact tracks

4. LAPPING The probe head contacts are lapped on a bare area of the contact substrate.

Use no more than 10 mils overtravel (vertical movement) to produce no more than 2 mils (0.05 mm) horizontal probe tip movement (skating).

Adjust the appropriate x- or y-axis micrometer head thimble to drag the probe 10 mils (0.25 mm), with the probe tip following. Avoid lateral motion.

Lapping is complete when each probe contact produces removed-material tracks. The check of full probe tip contact is done by examining the probe contact tracks or by checking electrical continuity on a metalized surface. A track should be left by each probe contact. The tracks do not have to be identical. Any mark (might be faint) indicates contact.

Probe head coaxial connectors

RF connectors not field replaceable A damaged RF connector is not field replaceable. Unscrewing an RF connector will break the connection to the probe board. An RF connector that turns in the probe head block is damaged and should be returned to Cascade Microtech for repair.

Probes can be shipped to the factory for inspection or repair if a probe problem is suspected. Please use a provided shipping container for the probes. See the following FACTORY INSPECTION OR REPAIR section.

Loose K Connector A loose K Connector that turns in the probe head block can be retightened. See steps 3 and 4 of the following REPLACEABLE K CONNECTOR PARTS section.

Replaceable K Connector parts A damaged K Connector can be replaced by the user. The threaded outer body ("sparkplug" launcher) can be unscrewed from the probe block. The center conductor and its plastic support bead is then removed.

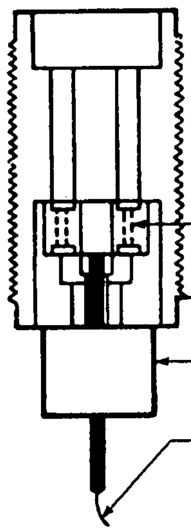


Fig. 3-5 K Connector "sparkplug" launcher

1. REMOVE 'SPARKPLUG" LAUNCHER Use two 1/4-36 nuts, placed on the outer body middle, to act as jam nuts. Tighten the nuts against each other, then turn the bottom nut to remove the outer body from the probe block. (The Wiltron -01-1 05 torquing kit has specific tools.)

2. REMOVE CENTER CONDUCTOR AND SUPPORT BEAD Use tweezers or needle nose pliers to remove the friction-fit center conductor and plastic support bead.

The glass bead, now exposed, is not removed. The glass bead center conductor is connected to the probe board.

3. INSTALL "SPARKPLUG" LAUNCHER A new assembly (Cascade Microtech part no. 013-009) is fiied to the probe block. The new assembly includes the outer body, center conductor, and support bead.

Use jam nuts to do the tightening. Tighten the nuts against each other, then turn the top nut to seat the assembly in the probe block. Tighten to 30 lbf . in (3.4 N. m).

4. ELECTRICAL CHECK Check the electrical performance of the replaced K Connector by contacting an impedance standard substrate short-circuit. Look for "suckouts" that indicate a poor connection interface.

Replaceable 2.4 mm connector parts A damaged 2.4 mm connector (200-series probes) can be replaced by the user. The threaded body ("sparkplug" launcher) can be unscrewed from the probe block.

1. REMOVE 'SPARKPLUG" LAUNCHER Use two 7 mm x 0.75-6g nuts, placed on the top threads, to act as jam nuts. Tighten the nuts against each other, then turn the bottom nut to remove the body from the probe block.

The glass bead, now exposed, is not removed. The glass bead center conductor is connected to the probe board.

2. INSTALL "SPARKPLUG" LAUNCHER A new assembly (Cascade Microtech part no. 105-008) is fitted to the probe block. Use jam nuts to do the final tightening. Tighten the nuts against each other, then turn the top nut to seat the assembly into the probe block. Tighten to 20-25 lbf-in (2.3-2.6 N· m).

3. ELECTRICAL CHECK Check the electrical performance of the replaced connector by contacting an impedance standard substrate short-circuit. Look for "suckouts" that indicate a poor connection interface.

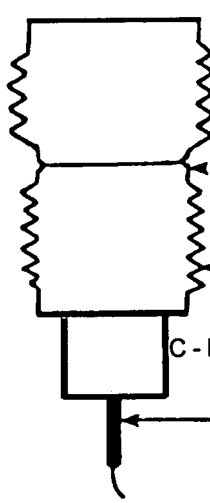


Fig. 3-6 2.4 mm connector "sparkplug" launcher

Coaxial connector inspection and cleaning

Connector inspection Repair or discard any defective connector. A damaged connector can damage other connectors.

Caution is necessary to prevent damage due to worn or out-of-specification connectors. All connectors will wear with continued use and should be checked at frequent intervals. Inspect each connector and use a mechanical gauge to check the center pin protrusion distance.

Isopropyl alcohol Use isopropyl alcohol to clean coaxial connectors.

> ◇ **Caution** Do not use a chlorinated solvent, such as trichloroethane (TCE), to clean coaxial connectors.

Wipe away debris on connectors with a foam-tipped swab, slightly moistened with isopropyl alcohol. Do not attempt to dissolve the debris. Allow the connector to dry completely before using the connector.

> Note Alcohol will absorb moisture from the room air.

Metallic particles Metallic particles imbedded in the dielectric should be removed. Use a sharp wooden pick and a magnifier. Clean with an isopropyl alcohol moistened swab, then use pressurized dry air or nitrogen to dry the connection.

Troubleshooting

1. Dirty wafer
2. Dirt under wafer
3. Dirt on probe tips
4. Uneven device
5. Dirt or burrs on arm-to-probe mounting surface
6. Short and load not correctly contacted
7. Probe tip worn irregularly

6\. Z-lever operated with probes already touching wafer

9\. Probe dropped

10\. Probes "crashed"

11\. Probe tip struck and broken by chuck

12\. Damaged arm

13\. Probe tip snagged during cleaning

14. Planarity adjustment not done correctly
15. Torque on probe head
16. Overtravel breaks tip
17. Trichloreothane or acetone used to clean probe
18. Probe tips not dry after ultraxonic cleaning
19. Ground isolators not installed
20. Damaged positioner ball bearings
21. Damaged positioner

Contact problems Nearly all mechanical problems will show up at the probe tips. However, most problems arise from a control setting, dirt, or other simple problem. Don't attempt to make adjustments before researching the problem.

> 0 Caution Do not adjust or loosen any factory-set adjustments.

Review the following partial list of probe contact problems or causes:

- DIRTY WAFERS Dirty wafers should be cleaned before probing.

- WAFER CHUCK TOP A panicle can be trapped under the wafer, causing tilt.

A check is to apply and release vacuum while observing the wafer through the microscope. With coaxial illumination any changes in reflected light will indicate the wafer is flexing over a panicle. Try rotating the wafer or wafer chuck to check for tilt.

Clean the wafer chuck with solvent and wipe with clean, lint-free, towels.

- PROBE TIP DIRT Dirt buildup can cause the probe tip to lose contact. Dirty wafers should be cleaned before probing.

- PROBE MOUNTING SURFACE Check for dirt and burrs between the probe-to-arm mounting surfaces.

- PROBE TIP DAMAGE Check the probe contacts for electrical continuity. Damage can be caused by dropping, "crashing" two probes, improper z-lever use, etc.

Look for an open circuit in one or more of the probe signal or ground lines. Use a continuity test or a network analyzer.

- TORQUE ON PROBE HEAD Use the positioner cable clamps to restrain the cables. The cable weight and torsion can affect measurements.

Misalignment can be caused by torque applied to the probe head. Semirigid coaxial cable can produce unwanted force unless carefully routed and formed. Arrange cabling and other components for no rotational force applied about the probe long axis.

- DAMAGED POSITIONER ARM A positioner arm can be bent if the postioner is dropped.

Factory inspection or repair

Probes Probes can be shipped to the factory for inspection or repair if a probe problem is suspected. Please use a provided shipping container for the probes. Call a Cascade Microtech representative to obtain an empty probe shipping container. Cascade Microtech will inspect the probe(s) and advise on the findings.

Before shipping, call the Cascade Microtech factory repairs representative for an authorization number. Place a reference to the authorization number in the shipment.

A repaired probe is tested before shipment. A repaired probe carries a 90 day warranty or the balance of your original warranty, whichever is greater.

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